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**METHOD FOR GENERATING CUSTOMIZED PHOTO ALBUM PAGES
AND PRINTS BASED ON PEOPLE AND GENDER PROFILES**

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**METHOD FOR GENERATING CUSTOMIZED PHOTO ALBUM PAGES
AND PRINTS BASED ON PEOPLE AND GENDER PROFILES**

FIELD OF THE INVENTION

5 The invention relates generally to the field of digital image processing, and in particular to a method for suggesting suitable designs for album pages and customized prints based on the image content and the demographics of people present in the images.

BACKGROUND OF THE INVENTION

10 With the advent of digital imaging technology, it has become possible for consumers to create customized products such as photo greeting cards, framed prints and albums inexpensively. Even if the original image is available only as a traditional paper print, it is possible to use a photo kiosk to
15 scan the image and use it creatively in a new print product.

 There are a number of commercially available software products that provide custom printing services to be used for printing on a home printer. Photo kiosks provide similar services for printing at the kiosk itself. Typically, these products provide a very wide selection of possible colors and designs for use
20 as background and/or around the border of the print. Most products also allow for the addition of text on or around the image, and there are numerous choices of fonts, sizes and colors available for this purpose. The user selects an image or a set of images to be used. Examples of custom printing software include Microsoft's Picture It, ArcSoft's PhotoPrinter, and others such as PrintSix,
25 PhotoElf and ImageBuddy.

 Albuming software products provide a variety of templates for page layout and themed decorations, in addition to backgrounds and borders. Some albuming softwares offer choices of music or audio to include with each album page of a digital album (soft copy), to produce a multimedia presentation for the
30 viewer. Some examples of albuming softwares include DogByte's Creative Photo

Album, flipalbum.com's FlipAlbum, Xequete's Diji album and also Microsoft's Picture It.

5 In a typical situation, the consumer needs to spend a lot of time at a task such as albuming or generating customized prints, most of the time being spent in searching for suitable image sets from the consumer's image collection and trying out the various options and their combinations till a visually pleasing combination is found. Since software products in this application area typically offer hundreds of options for each choice to be made (in some cases, thousands), it is increasingly difficult for a consumer to produce an effective presentation of
10 their image(s) easily and quickly. The consumer can get tired of exploring all possible combinations and settle on one which does not meet all their criteria, causing dissatisfaction.

In U.S. Patent No. 6,389,181 issued on May 14, 2002, Shaffer et al discuss a method for automatically producing a photocollage by employing image
15 recognition techniques. However, their method of selecting layout and page design is based on the availability of a customer profile containing the customer's color preferences, layout preferences and design considerations. The image content is not used in this process. Face recognition is used for grouping images, assuming that sample faces and identification of all members of the customer's
20 family are available in the customer profile. A scenario where a comprehensive customer profile such as this is available is hard to achieve in practice.

In the International Application WO 02/01537 A2 published on January 3, 2002, Cohen-Solal et al use demographic information and the number of people, as in the present invention, for adapting the content of a display screen.
25 Here, these characteristics are estimated from live video feed and mapped to audio-visual presentations that will be most relevant for viewing, given the current audience. The mapping is customized to cater to the interests of specific groups, for example, a primarily male audience may prefer sports highlights or a frequently moving audience may require short presentations. A similar automatic
30 customization would be useful but is currently unavailable for the album generation process.

A need therefore exists to provide the consumer with fewer, but well-crafted, choices that would help them to achieve the given task (albuming, custom printing, etc.) quickly and satisfactorily. The suggested choices should be appropriate for the image content displayed, and provide a complete solution that takes into account all the interactions between individual elements, e.g., the color of background should work well with the border chosen. This process would not limit the consumers' choices, as the suggestions could provide the starting points for more explorations if the consumer so wishes.

SUMMARY OF THE INVENTION

The present invention is directed to overcoming one or more of the problems set forth above. Briefly summarized, according to one aspect of the present invention, the invention resides in a method for generating customized photo album pages for a collection of digital images, where the method comprises the steps of: (a) obtaining a plurality of digital images; (b) automatically grouping the images into one or more image sets based on at least one of grouping by events and grouping by people present in the images; (c) automatically profiling the images within each image set according to image content, thereby relating a particular image set to one or more design themes; (d) providing a database of design elements that may be used to generate customized photo album pages; (e) utilizing the design themes generated by the profiling step to automatically suggest one or more design elements from the database of design elements; and (f) automatically generating a customized photo album page layout for each image set by applying one or more of the suggested design elements to the page layout.

The manual selection of image sets for albuming/custom printing is a time-consuming process involving browsing large image collections. According to one of its advantages, this invention provides an automated solution to the problem of finding image sets that form a cohesive unit for the albuming task. The user can select image sets by event, or by people present in the images, or a combination of the two methods, e.g., images of a particular person taken during a particular event.

It is a well-known observation that the type of themes selected by consumers for displaying their image(s) is closely related to the gender and ages of the people appearing in the images. For example, a baby's picture is displayed with themed embellishments such as toys. A girl's portrait may be displayed with colors such as pink and floral motifs. An adult male and female may fit the model of a couple, and the consumer may be looking for themes suitable for a couple. Similarly, a scene without any people (such as scenery) may need to be displayed with colors that complement the color composition of the scene.

According to another of its advantages, the present invention uses the demographics, image type (portrait, large group, etc.) and the color content of images as the basis for selection of a group of suggested display elements. The options suggested are based on a custom-designed mapping between image characteristics and display element groups that takes into account current trends in design and cultural preferences. Once created, this mapping would produce suitable photo decoration options for different types of situations, making the process of photo product generation at the kiosk or home more pleasurable and less time consuming.

These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a flowchart of the overall system for automation-aided albuming proposed in the present invention.

Figure 2 is a flowchart of the method of determining display elements in the present invention.

Figure 3 is a flowchart of the gender classification method according to the present invention.

Figure 4 is an illustration of the location of facial feature points on a human face.

Figure 5 is a table of measurement-based features used for gender classification in the present invention.

Figure 6A defines a set of bounding boxes identifying a set of image patches and Figure 6B shows a table of histogram features based on
5 differences between the patches identified in Figure 6A, and as used for gender classification in the present invention.

Figure 7 is an example of a table mapping photo profile information to design groups.

Figure 8 shows two examples of design elements suggested by the
10 proposed system.

DETAILED DESCRIPTION OF THE INVENTION

Because image processing systems employing albing software are well known, the present description will be directed in particular to attributes
15 forming part of, or cooperating more directly with, method in accordance with the present invention. Attributes of the method not specifically shown or described herein may be selected from those known in the art. In the following description, a preferred embodiment of the present invention would ordinarily be implemented as a software program, although those skilled in the art will readily recognize that
20 the equivalent of such software may also be constructed in hardware. Given the method as described according to the invention in the following materials, software not specifically shown, suggested or described herein that is useful for implementation of the invention is conventional and within the ordinary skill in such arts. If the invention is implemented as a computer program, the program
25 may be stored in conventional computer readable storage medium, which may comprise, for example; magnetic storage media such as a magnetic disk (such as a floppy disk or a hard drive) or magnetic tape; optical storage media such as an optical disc, optical tape, or machine readable bar code; solid state electronic storage devices such as random access memory (RAM), or read only memory
30 (ROM); or any other physical device or medium employed to store a computer program.

The present invention provides the consumer with a suggested set of choices for *display elements* that are appropriate for the type(s) of picture(s) used in the photo product. Image sets can be selected based on grouping by events or by people or a combination of the two. Display elements consist of image backgrounds, borders, frames, layouts, background music (for digital albums) and any other display options provided by the system. The selection of the various display elements is based on the content of the image; with emphasis on the description of people present in the image. Automatic image processing algorithms are used to determine if people are present in an image, and demographic information (gender and age) about them. This invention provides an automated solution to the problem of finding image sets that form a cohesive unit for the alumping task. The user can select image sets by event, or by people present in the images, or a combination of the two methods, e.g., images of a particular person taken during a particular event.

Referring to Figure 1, the consumers' digital image collection or a subset thereof **10** is grouped by event **12** and by people present in images **14**. The consumer may choose either criteria—event or people—for grouping, or both in any order, based on the semantics of the task. For example, to create an album of the events in a baby's first year, the user may first group images by people, and then group by events after selecting the group depicting the baby; whereas, to create an album to share vacation experiences with a friend, the user may first group by event (vacation) and then by people (to find images containing the user). Grouping by event **12** is achieved using the method described in U.S. Patent No. 6,351,556, entitled "A Method for Automatically Comparing Content of Images for Classification into Events", by Loui and Pavie issued on February 26, 2002; and grouping by the identity of people present in the images **14** uses the method of clustering by facial similarity described in U.S. Serial No. 10/143,272, entitled "Method and Apparatus for Organizing and Retrieving Images Containing Human Faces" filed 10 May 2002 in the names of Chen et al, both of which are incorporated herein by reference.

The user can then select the group(s) 16 of images to include in the album. The grouping algorithms also provide emphasis scores to each image relative to other images in the group. In grouping by people, an emphasis score is assigned to each retrieved image, given by the fraction of the image covered by the
5 faces of the specified people. In event-based grouping, this score is based on image quality (sharpness, contrast, etc.) and composition. The emphasis scores are used by the layout engine 18 to generate page layouts, as described in U.S. Serial No. 09/750,858, entitled "System and Method for Automatic Layout of Images in Digital Albums" by Geigel and Loui filed on 29 December 2000, which
10 is incorporated herein by reference. The design engine 20, which uses the method described in connection with Figure 2, is then used to suggest designs appropriate for the selected image set from the database of design elements 22 based on the photo profile generated. The album page(s) 24 are created with the selected layout and design choices.

15 Referring to Figure 2, which shows the design engine 20 of Figure 1, human faces are located 110 in the digital image(s) selected by the user for creating a customized print or album page. There are a number of known face detection algorithms that can be used for this purpose. In a preferred embodiment, the face detector described in commonly-assigned U.S. Serial No. 10/042,605,
20 entitled "Method and System for Processing Images for Themed Imaging Services" filed January 9, 2002 by Nicponski is used, which is incorporated herein by reference. The face detector is based on a Bayesian classifier trained with examples of face and non-face images. The face detector outputs the locations and sizes of faces found in the image(s). Based on the number and size of faces
25 detected, the image is assigned 112 an *image type* – for example, portrait (or close-up), group portrait, snapshot, large group or non-face. Each face detected is classified 114 as baby, child, adult or senior. A method for assigning a face to an age category is described in U.S. Patent No. 5,781,650, entitled "Automatic Feature Detection and Age Classification of Human Faces in Digital Images" by
30 Lobo issued on July 14, 1998, which is incorporated herein by reference. That method uses ratios of facial measurements that are known to change with age due

to bone structure development. The adult faces are further classified **116** as male or female. A gender classification method described in “Learning Gender with Support Faces” by B. Moghaddam and M.-H. Yang in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 24, no. 5, pp. 707-711, May 2002, can be used for the purpose, which is incorporated herein by reference. However, this method is not accurate (a correct classification rate of about 70% is observed) on un-aligned faces, where the eye locations are not known accurately (as in this case). In the preferred embodiment, gender classification involves the steps shown in Figure 3.

The approximate eye locations are obtained **120** from the face detector and used to initialize the starting face position for facial feature finding. Eighty-two facial feature points are detected **121** using the Active Shape Model-based method described in “An automatic facial feature finding system for portrait images”, by Bolin and Chen in the *Proceedings of IS&T PICS conference, 2002*, which is incorporated herein by reference. Their method uses local texture matching to localize feature points, followed by the application of global shape constraints learned from training examples. Figure 4 shows the locations of the feature points on a face.

Some facial measurements that are known to be statistically different between men and women (ref. “Anthropometry of the Head and Face” by Farkas (Ed.), 2nd edition, Raven Press, New York, 1994, and “What’s the difference between men and women? Evidence from facial measurement” by Burton, Bruce and Dench, *Perception*, vol. 22, pp. 153-176, 1993) are computed **122**. Figure 5 lists the features used, where P_n refers to facial point number n from Figure 4. The features are normalized by the inter-ocular distance, to eliminate the effect of differences in the raw size of the face. For symmetrical features, measurements from the left and right side of the faces are averaged to produce more robust measurements.

According to the invention, additional performance improvement is obtained by using the presence or absence of hair in specific locations on and around the face as cues for gender determination. These features are incorporated

124 as a difference in gray-scale histograms between the patch where hair may be present, and a reference patch on the cheek that is typically hairless. The bounding box for the patches are automatically computed as shown in Figure 6A based on the feature points, and relevant histogram difference-based features are
5 computed as shown in Figure 6B.

Binary classifiers are constructed 126 using each of the twenty-two single features (listed in Figure 5 and 6) separately. Simple Bayesian classifiers described in standard literature (Pattern Classification by R.O. Duda, P.E. Hart and D.G. Stork, John Wiley and Sons, 2001) are trained on large sets of example
10 male and female faces to produce the single feature-based binary classifiers. The classification accuracy of each of these binary classifiers ranged from 55 to 75%.

The binary classifiers were combined using the AdaBoost algorithm to produce 128 an improved final classifier. AdaBoost is a well-known algorithm for boosting classifier accuracy by combining the outputs of weak
15 classifiers (such as the single feature binary classifiers described above). The weighted sum of outputs of the weak classifiers is compared with a threshold computed automatically from the training examples. A description and application of this method is available in “Rapid Object Detection using a Boosted Cascade of Simple Features” by P. Viola and M. Jones, in *International*
20 *Conference on Computer Vision and Pattern Recognition*, 2001, which is incorporated herein by reference. The classification accuracy of the final classifier obtained using AdaBoost was 90% on un-aligned faces.

Referring back to Figure 2, and based on the information computed above, each image is assigned 118 a *photo profile*, which includes the image type,
25 the ages and genders of the people (if any) present in the image, and the color distributions in the image. The color distribution is described as the proportion of pixels in each of the major color categories as defined in “The ISCC-NBS method of designating colors and a dictionary of color names” by K.L. Kelly and D.B. Judd in the *National Bureau of Standards Circular (553)*, Nov 1, 1955 – red, blue,
30 yellow, green, pink, purple, brown, orange, olive, white, black and gray.

A large number of consumer images from family photo collections, where the relationships between individuals were known, are analyzed to determine if there are any likely relationships given the age and genders detected. These common scenarios are used to pick out designs 119 appropriate in that scenario. Figure 7 shows some examples of tables that map the photo profiles to design themes. Each design group needs to be custom-designed and updated periodically to reflect current trends in design and cultural preferences. The color of the design elements, border and background are selected based on the color distribution in the image. The color scheme in each case may be coordinating (colors pre-dominant in the image are chosen), complementary (colors contrasting with the pre-dominant colors in the image are chosen) or neutral (unsaturated versions of the pre-dominant colors are chosen). If the product being created is a multimedia presentation, music clippings are also suggested as part of the design theme based on gender and ages of people in the images.

At the end of the process, the user is presented with a limited number (typically around 5) of complete design selections. Abstracts and neutrals are included in the options in all cases, since there may be errors in face detection and the age/gender determination steps. Figure 8 shows two examples of the design elements suggested for a page with portrait pictures of a baby (left) and a page with group pictures of girl children (right).

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

PARTS LIST

10	digital image collection
12	event grouping
14	people grouping
16	group selection
18	layout engine
20	design engine
22	database of design elements
24	album pages
110	locate faces step
112	assign image type step
114	classify by age group step
116	classify by gender step
118	create photo profile step
119	choose display elements step
120	get eye locations step
121	locate feature points step
122	compute facial measurements step
124	compute histogram-based features step
126	compute binary classifiers step
128	combine binary classifiers step